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Bedside Prediction of 30-day Adverse Outcomes in ACS Using Shock Index, NLR, and Creatinine

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Abstract

Objectives: Early risk stratification in acute coronary syndrome (ACS) is crucial for guiding management and improving outcomes. Although established scores such as thrombolysis in myocardial infarction and Global Registry of Acute Coronary Events are widely used, their complexity and reliance on multiple parameters may limit practicality in emergency settings. We aimed to investigate whether a simple combination of three routinely available parameters, shock index (SI), neutrophil-to-lymphocyte ratio (NLR), and serum creatinine, could predict 30-day major adverse cardiovascular events (MACE) in ACS patients.

Materials and Methods: This single-center retrospective cohort study included 500 consecutive ACS patients [ST-elevation myocardial infarction (STEMI), non-STEMI, unstable angina] admitted between January 2021 and December 2022. SI was calculated as heart rate divided by systolic blood pressure; NLR was obtained from a routine blood count; and serum creatinine was measured on admission. We evaluated the association of these parameters, individually and in combination, with 30-day MACE, defined as all-cause mortality, recurrent myocardial infarction, urgent target-vessel revascularization, or stroke. Logistic regression, ROC analysis, calibration plots, and decision curve analysis were performed.

Results: Thirty-day MACE occurred in 56 patients (11.2%). SI ≥0.8 [odds ratio (OR): 2.10; 95% confidence interval (CI): 1.28-3.44], NLR ≥3 (OR: 1.85; 95% CI: 1.14-3.01), and creatinine >1.2 mg/dL (OR: 2.28; 95% CI: 1.39-3.75) were independent predictors. The model combining all three parameters demonstrated strong discriminative ability (area under the curve: 0.80; 95% CI: 0.74-0.85) and performed better than the individual parameters.

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Conclusion: The three-parameter model (SI, NLR, creatinine) provides a rapid, low-cost, and practical method for bedside risk stratification in ACS patients. This simple model demonstrates strong predictive accuracy for 30-day MACE and may serve as a complementary tool to established risk scores. Further multicenter studies are required to validate its utility.

Keywords: Acute coronary syndrome, shock index, neutrophil-to-lymphocyte ratio, creatinine, major adverse cardiovascular events

Introduction

Acute coronary syndrome (ACS) remains one of the leading causes of morbidity and mortality worldwide. Early identification of patients at highest risk is critical for tailoring therapeutic strategies, guiding invasive management, and improving survival. Several risk scores, including the Global Registry of Acute Coronary Events (GRACE) score and the Thrombolysis in Myocardial Infarction (TIMI) score, have demonstrated prognostic utility and are endorsed by international guidelines[1]. However, these tools require multiple clinical, laboratory, and electrocardiographic parameters, which may not always be readily available in emergency settings. Their complexity and computational burden can also limit bedside applicability, particularly in overcrowded or resource-limited environments.

In contrast, simple and universally available parameters may offer rapid and effective prognostic insights. The shock index (SI), defined as the ratio of heart rate to systolic blood pressure, has long been associated with hemodynamic instability and poor short-term outcomes in ACS. The neutrophil-to-lymphocyte ratio (NLR), a marker of systemic inflammation, has been linked to larger infarct size, impaired ventricular recovery, and higher rates of major adverse cardiovascular events (MACE)[2]. Similarly, elevated serum creatinine and impaired renal function are well-established predictors of adverse cardiovascular outcomes. Each of these parameters has prognostic value individually, but their combined use in a simple model for ACS risk stratification has not been systematically evaluated. This study examined whether the integration of SI, NLR, and creatinine could serve as a practical bedside tool to predict 30-day outcomes in ACS patients. We hypothesized that the three-parameter model would provide strong discrimination and calibration for short-term risk, offering a complementary approach to existing, more complex risk scores.

Materials and Methods

Study Design and Population

This single-center retrospective cohort study included 500 consecutive patients admitted with ACS, including ST-elevation myocardial infarction (STEMI), non-STEMI (NSTEMI), and unstable angina, between January 2021 and December 2022. The diagnosis of ACS was established based on current European Society of Cardiology guidelines, integrating clinical presentation, electrocardiographic changes, and elevated cardiac biomarkers. Patients with incomplete laboratory data, active infection, autoimmune or hematologic diseases, chronic inflammatory disorders, malignancies, or those receiving immunosuppressive treatment were excluded. Of 560 consecutive patients initially screened, 60 were excluded due to missing laboratory data (n=28), active infection (n=12), autoimmune or hematologic disease (n=8), chronic inflammatory disorders (n=6), and malignancy or immunosuppressive therapy (n=6), resulting in a final study population of 500 patient.

The study protocol was reviewed and approved by the University of Health Sciences Türkiye, Diyarbakır Gazi Yaşargil Training and Research Hospital Ethics

Committee (approval no: 676, date: 24.10.2025). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Given the retrospective design, the requirement for written informed consent was waived by the local ethics committee.

Data Collection and Definitions

Demographic characteristics (age, sex), cardiovascular risk factors (hypertension, diabetes mellitus, smoking), and hemodynamic and laboratory parameters at admission were retrieved from the hospital electronic medical records.

- SI was calculated as the ratio of heart rate (beats/min) to systolic blood pressure (mmHg).
- NLR was calculated by dividing the absolute neutrophil count by the absolute lymphocyte count obtained from the complete blood count on admission.
- Serum creatinine level was measured on admission using the Jaffe method.

Based on prior literature, the following cut-off values were predefined: SI ≥0.8, NLR ≥3, and creatinine >1.2 mg/dL. Each variable was considered a binary risk factor (present/absent), and a composite three-parameter model was constructed by combining these indices.

Endpoints

The primary endpoint was the occurrence of 30-day MACE, defined as a composite of all-cause mortality, recurrent myocardial infarction, urgent target vessel revascularization, or stroke within 30 days after the index event. Follow-up data were obtained from hospital records and verified by telephone interviews when necessary.

Statistical Analysis

All analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were tested for normality using the Kolmogorov-Smirnov test and were expressed as mean ± standard deviation (SD) or median (interquartile range) as appropriate. Categorical variables were presented as counts and percentages. Comparisons between groups [(MACE (+) vs. MACE (–)] were made using the Student's t-test or Mann-Whitney U test for continuous variables, and the chi-square test or Fisher's exact test for categorical variables.

Variables with $p<0.10$ in univariate analyses were included in the multivariable logistic regression model to determine independent predictors of 30-day MACE. The results were reported as odds ratios (ORs) with 95% confidence intervals (CIs).

Discriminatory performance was evaluated using ROC curve analysis, and the area under the curve (AUC) was calculated for each parameter and for the combined model. Calibration was assessed by the Hosmer-Lemeshow goodness-of-fit test and visual inspection of calibration plots. Internal validation was performed using bootstrap resampling (1.000 iterations). Additionally, decision curve analysis (DCA) was conducted to assess the net clinical benefit of the three-parameter model compared with the "treat-all" and "treat-none" strategies. A two-tailed p value <0.05 was considered statistically significant.

Results

Among 500 patients, the mean age was 62±11 years; 28% were female, 55% were hypertensive, 32% were diabetic, and 41% were smokers. STEMI was present in 46%, NSTEMI in 37%, and unstable angina in 17%. The 30-day MACE rate was 11.2% (56 patients). Baseline demographic and clinical characteristics stratified by MACE are shown in Table 1. Univariable and multivariable analyses confirmed SI ≥0.8, NLR ≥3, and creatinine >1.2 mg/dL as independent predictors (Table 2). The three-parameter model stratified patients into low-, intermediate-, and high-risk groups (Table 3). The model achieved an AUC of 0.80 and outperformed SI and NLR individually, demonstrating excellent calibration (Figure 1). DCA confirmed a net clinical benefit (Figure 2).

Baseline Characteristics

Baseline demographic and clinical characteristics according to MACE status are summarized in Table 1.

Table 1. Baseline demographic and clinical characteristics of the study population

Variable	Total (n=500)	MACE (+) (n=56)	MACE (-) (n=444)	p-value
Age, years (mean ± SD)	62±11	67±12	61±11	<0.01
Female sex, n (%)	140 (28)	20 (36)	120 (27)	0.12
Hypertension, n (%)	275 (55)	40 (71)	235 (53)	0.01
Diabetes mellitus, n (%)	160 (32)	25 (45)	135 (30)	0.02
Current smoker, n (%)	205 (41)	27 (48)	178 (40)	0.24
STEMI, n (%)	230 (46)	32 (57)	198 (45)	0.08
NSTEMI, n (%)	185 (37)	18 (32)	167 (38)	0.39
Unstable angina, n (%)	85 (17)	6 (11)	79 (18)	0.21
Killip class ≥II, n (%)	90 (18)	20 (36)	70 (16)	<0.001
Shock index ≥0.8, n (%)	200 (40)	32 (57)	168 (38)	0.004
NLR ≥3, n (%)	240 (48)	35 (62)	205 (46)	0.02
Creatinine >1.2 mg/dL, n (%)	120 (24)	25 (45)	95 (21)	<0.001
PCI performed, n (%)	350 (70)	41 (73)	309 (70)	0.65
30-day MACE, n (%)	56 (11.2)	-	-	-

STEMI: ST-elevation myocardial infarction, NSTEMI: Non-ST-elevation myocardial infarction, NLR: Neutrophil-to-lymphocyte ratio, PCI: Post-percutaneous coronary intervention, MACE: Major adverse cardiovascular events, SD: Standard deviation

Table 2. Multivariable logistic regression analysis for predictors of 30-day MACE

Predictor	Odds ratio (95% CI)	p-value
Shock index ≥0.8	2.10 (1.28-3.44)	0.003
NLR ≥3	1.85 (1.14-3.01)	0.012
Creatinine >1.2 mg/dL	2.28 (1.39-3.75)	0.001

MACE: Major adverse cardiovascular events, NLR: Neutrophil-to-lymphocyte ratio, CI: Confidence interval

Table 3. Risk stratification of the study population according to the three-parameter model

Risk group	N	30-day MACE, n (%)	Relative risk vs. low risk
Low (0-2 factors)	210	13 (6%)	Reference
Intermediate (1-2 factors)	190	27 (14%)	2.3
High (3 factors)	100	27 (27%)	4.3

MACE: Major adverse cardiovascular events

Patients who developed MACE were significantly older (67±12 vs. 61±11 years, p<0.01) and more likely to have hypertension (p=0.01) and diabetes mellitus (p=0.02). The proportion of patients with Killip class ≥II was notably higher in the MACE group (36% vs. 16%, p<0.001), indicating greater hemodynamic compromise. Laboratory and hemodynamic markers associated with poor outcomes included SI ≥0.8 (57% vs. 38%, p=0.004), NLR ≥3 (62% vs. 46%, p=0.02), and creatinine >1.2 mg/dL (45% vs. 21%, p<0.001).

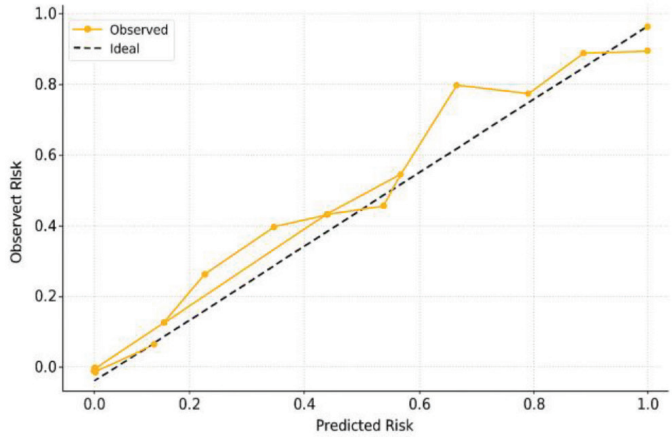

Figure 1. Calibration plot for the three-parameter model

Univariable and Multivariable Predictors

Univariable logistic regression analysis identified age, hypertension, diabetes mellitus, Killip class ≥II, SI ≥0.8, NLR ≥3, and creatinine >1.2 mg/dL as significant predictors of 30-day MACE. When these variables were entered into the multivariable model, SI ≥0.8 (OR: 2.10, 95% CI: 1.28-3.44, p=0.003), NLR ≥3 (OR: 1.85, 95%

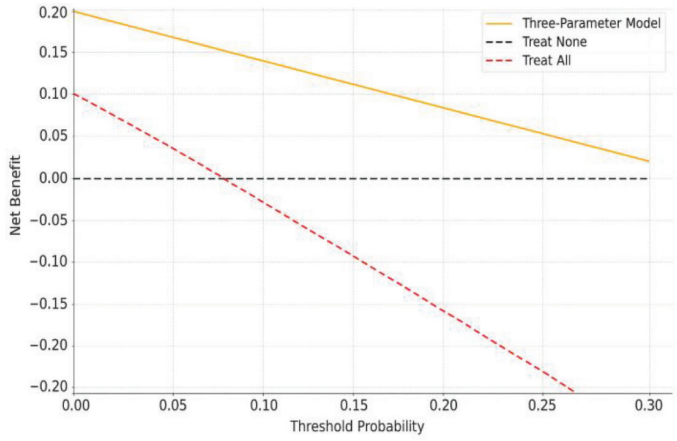

Figure 2. Decision curve analysis for the three-parameter model

CI: 1.14-3.01, p=0.012), and creatinine >1.2 mg/dL (OR: 2.28, 95% CI: 1.39-3.75, p=0.001) remained independent predictors.

Three-Parameter Model and Risk Stratification

Patients were classified into three risk categories based on the cumulative number of adverse factors (SI ≥0.8, NLR ≥3, and creatinine >1.2 mg/dL). As shown in Table 3, event rates increased progressively across categories: 6% in the low-risk group (0 factors), 14% in the intermediate group (1-2 factors), and 27% in the high-risk group (3 factors) (p<0.001 for trend). The relative risk of MACE was approximately 4.3-fold higher in patients with all three risk factors compared to those without.

Model Performance and Validation

ROC curve analysis demonstrated strong discriminatory ability of the three-parameter model with an AUC of 0.80 (95% CI: 0.74-0.85), outperforming individual predictors (SI=0.67, NLR=0.70, creatinine =0.73). The calibration plot (Figure 1) showed excellent agreement between predicted and observed MACE rates, with a non-significant Hosmer-Lemeshow test (p>0.05) indicating good model fit. Internal validation by bootstrap resampling (1.000 iterations) confirmed model stability. DCA (Figure 2) revealed a net clinical benefit of the three-parameter model across a wide range of threshold probabilities, outperforming both "treat-all" and "treat-none" strategies.

Table 1 compares demographic, clinical, and laboratory parameters between MACE (+) and MACE (-) patients. Significant predictors of adverse outcomes included older age, hypertension, diabetes, elevated SI, elevated NLR, and elevated creatinine.

Table 2 presents independent predictors of 30-day MACE. SI ≥0.8, NLR ≥3, and creatinine >1.2 mg/dL retained statistical significance in the multivariable model, confirming their prognostic value.

Table 3 shows the incremental risk of 30-day MACE with an increasing number of abnormal parameters, confirming the additive prognostic value of combining SI, NLR, and creatinine.

Calibration plot showing agreement between predicted and observed probabilities of 30-day MACE. The Hosmer-Lemeshow test was non-significant, confirming good calibration.

The calibration plot demonstrates close alignment between predicted and observed probabilities of 30-day MACE. The non-significant Hosmer-Lemeshow test supports adequate calibration.

DCA indicating net clinical benefit of using the three-parameter model across a range of threshold probabilities compared with strategies of treating all or none.

DCA indicates that the use of the three-parameter model confers a consistent net clinical benefit across multiple decision thresholds compared with treating all or treating none.

Discussion

In this study, we demonstrated that a simple combination of three routinely available parameters — SI, NLR, and serum creatinine — provides strong predictive value for short-term adverse outcomes in patients with ACS. The three-parameter model showed excellent discrimination and calibration for predicting 30-MACE, outperforming each individual marker. The model's practicality and rapid

applicability make it a valuable complement to traditional risk scores, such as GRACE and TIMI, particularly in emergency and resource-limited settings[3].

The early recognition of high-risk ACS patients remains a cornerstone of effective management. Despite the availability of validated risk scores, their clinical use may be limited by the need for multiple variables, complex calculations, or specialized software[4]. In contrast, SI, NLR, and creatinine are available at admission and do not require complex calculations. Our findings suggest that combining these parameters allows for rapid bedside risk assessment without sacrificing predictive accuracy.

The SI reflects the balance between cardiac output and vascular tone, offering a dynamic estimate of hemodynamic instability. Previous studies have shown that elevated SI is associated with increased mortality and a higher incidence of cardiogenic shock after myocardial infarction. In our cohort, SI ≥0.8 independently predicted 30-day MACE, reinforcing its role as an early warning indicator[5].

The NLR is a robust inflammatory marker that integrates two complementary immune responses: neutrophilia indicating acute stress and lymphopenia reflecting impaired immune regulation. Elevated NLR has been associated with larger infarct size, microvascular dysfunction, and post-percutaneous coronary intervention (PCI) complications[6,7]. Our results align with prior observations linking inflammation to plaque instability and thrombotic risk, supporting NLR as a strong, inexpensive prognostic indicator.

The prognostic impact of serum creatinine emphasizes the importance of renal function in cardiovascular outcomes. Even mild renal impairment has been associated with higher mortality and reinfarction rates after ACS. Creatinine reflects both hemodynamic stress and underlying comorbidities, and its inclusion in the model improved overall risk discrimination. The independent association between creatinine >1.2 mg/dL and MACE underscores that renal function should not be overlooked during early ACS evaluation.

The association of elevated SI, NLR, and creatinine with adverse outcomes likely reflects the interplay between hemodynamic stress, inflammation, and renal dysfunction. An increased SI indicates reduced stroke volume and compensatory tachycardia, signaling early circulatory compromise. Elevated NLR represents systemic inflammatory activation and oxidative stress, both of which promote endothelial dysfunction and plaque instability. Concurrently, renal impairment reflected by elevated creatinine can exacerbate inflammatory cytokine release, impair endothelial nitric oxide production, and alter volume status, creating a self-perpetuating cycle that worsens myocardial ischemia and impairs recovery[8,9]. Thus, these parameters collectively capture the hemodynamic-inflammatory-metabolic continuum underlying early cardiovascular deterioration in ACS.

The combined use of SI, NLR, and creatinine integrates three complementary dimensions of ACS pathophysiology: hemodynamic compromise, inflammatory activation, and renal dysfunction. Individually, each parameter has prognostic significance, but their coexistence may reflect a compounded risk phenotype characterized by reduced perfusion, systemic inflammation, and metabolic stress. This integrated approach enhances risk discrimination and explains the superior predictive accuracy of the three-parameter model compared with that of each individual variable.

Our results are consistent with several prior studies that highlighted the individual prognostic power of these parameters. Wang et al. [10] demonstrated that elevated SI predicted short-term mortality after STEMI, while Kaya et al. [11] found that NLR independently predicted in-hospital MACE in ACS patients. Similarly, Yildiz et al.[4] reported that serum creatinine levels on admission were strongly correlated with 30-day mortality and recurrent ischemia. However, the present study is among the few to evaluate the combined prognostic value of these three markers within a single, easily applicable model.

Unlike multifactorial risk scores requiring numerous inputs, the proposed three-parameter model captures

hemodynamic, inflammatory, and metabolic pathways simultaneously, providing a holistic yet simple bedside assessment. The good calibration and clinical benefit shown in DCA indicate that this model can meaningfully aid clinical decision-making, especially in settings where rapid triage is essential.

In daily practice, this model could serve as an initial screening tool to identify high-risk patients requiring urgent invasive management or intensive monitoring. Its integration into emergency department triage protocols may help prioritize limited resources and guide the timing of coronary angiography or PCI. Furthermore, it could be used alongside established scores to enhance prognostic precision without additional cost or delay.

Study Limitations

Several limitations should be acknowledged. First, this was a single-center retrospective study, which may limit the generalizability of the findings. Second, although the study included a relatively large cohort, external validation in independent and multicenter populations is required before broad clinical adoption. Third, only baseline measurements were used; dynamic changes in SI, NLR, or creatinine during hospitalization were not evaluated and might provide additional prognostic insight. Fourth, we did not assess long-term outcomes beyond 30 days, which could have offered further understanding of the model's predictive value over time. Finally, unmeasured confounders such as medication use, infarct size, and ejection fraction may have influenced the results despite statistical adjustment.

Despite these limitations, the present study offers practical clinical insight by proposing a simple, cost-effective, and accessible bedside model that can complement existing risk assessment strategies.

Conclusion

The present study demonstrates that a simple combination of three routinely available parameters SI, NLR, and serum creatinine — can effectively predict 30-day adverse cardiovascular outcomes in patients with ACS. The proposed three-parameter model demonstrates strong discriminative performance and good calibration, outperforming each individual variable used alone.

This model is practical, inexpensive, and readily applicable at the bedside, allowing rapid early risk assessment without complex calculations or additional resources. Incorporating hemodynamic, inflammatory, and renal components, it offers a comprehensive yet simple representation of patient risk.

The findings suggest that this model could serve as a complementary tool to established risk scores for initial triage and clinical decision-making in emergency and critical care settings. Future multicenter prospective studies involving larger, more diverse populations are warranted to validate its predictive accuracy and to confirm its utility across different clinical settings. Nevertheless, further multicenter, prospective studies with larger and more diverse populations are warranted to confirm these findings.

Ethics

Ethics Committee Approval: The study protocol was reviewed and approved by the University of Health Sciences Türkiye, Diyarbakır Gazi Yaşargil Training and Research Hospital Ethics Committee (approval no: 676, date: 24.10.2025). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

Informed Consent: This single-center retrospective cohort study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: Yeter Arslan, G Söner S, Concept: Yeter Arslan G Söner S, Design: Yeter Arslan G. Söner S, Data Collection and/or Processing: Yeter Arslan G. Söner S, Analysis and/or Interpretation: Yeter Arslan G. Söner S, Literature Search: Yeter Arslan G, Söner S, Writing: Yeter Arslan G, Söner S

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